

Rates of Reaction

Contents

Particles and collisions

Temperature

Concentration

Surface area and catalysts

Summary activities

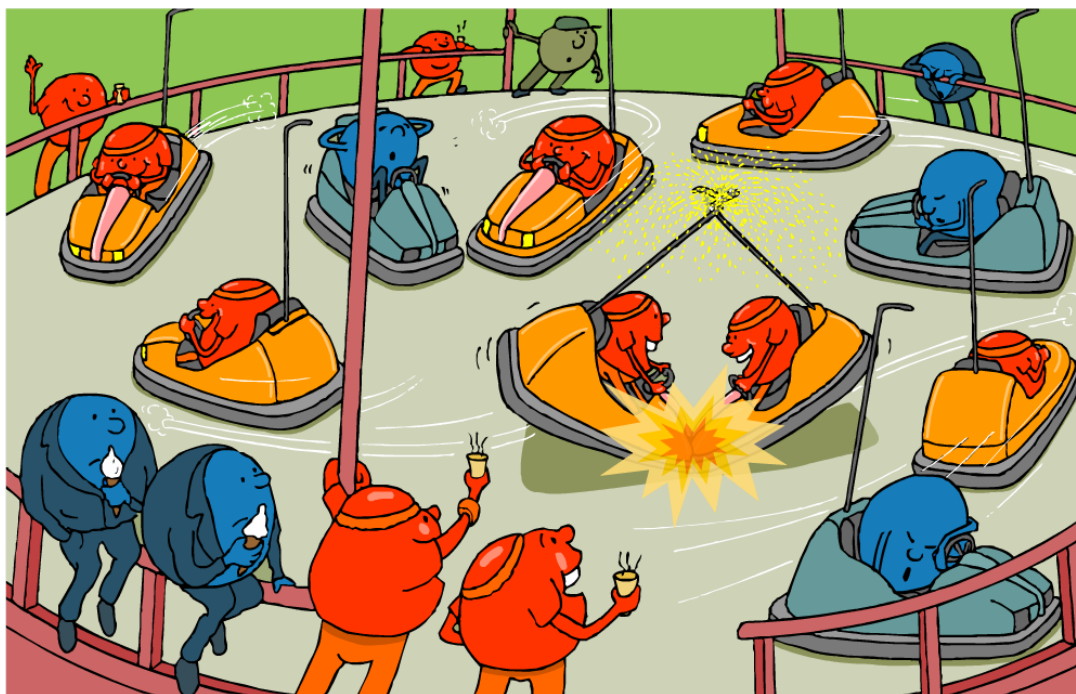




Whether they are just vibrating in place or moving around at a rapid pace, particles are ALWAYS in motion!

Kinetic energy is **MOVING ENERGY**

Remember from
semester 1 – kinetic
energy is dependant on
the mass of an object
or particle and its velocity





What does rate of reaction mean?

The speed of different chemical reactions varies hugely. Some reactions are very fast and others are very slow.

The **Reaction Rate** is the speed of a reaction.

What is the rate of these reactions?



slow

fast

very fast





Reactions, particles and collisions



The **collision theory** states:

- particles must collide to react
- particles must collide with enough energy to react
- particles must be oriented in a way that allows them to react

Activation energy is the minimum amount of energy needed for the particles to react and is different for each reaction.

The rate of a reaction depends on two things:

- the **frequency** of collisions between particles
- the **energy** with which particles collide.





Changing the rate of reactions

Anything that increases the number of successful collisions between reactant particles will speed up a reaction.

What factors affect the rate of reactions?

- increased **temperature**
- increased **concentration** of dissolved reactants
- increased **surface area** of solid reactants
- use of a **catalyst**.



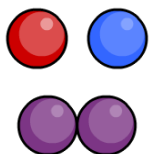
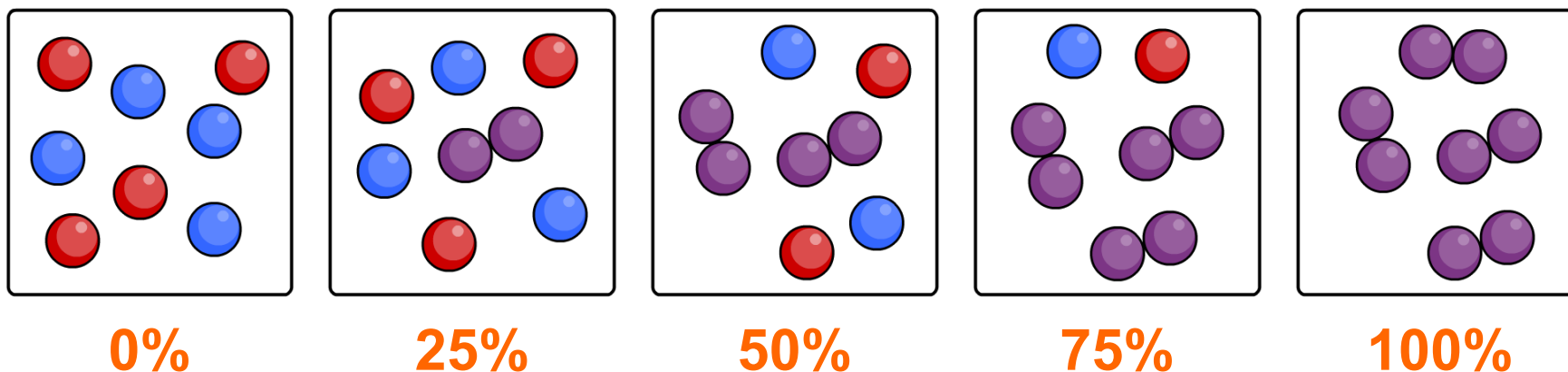


Slower and slower!

Reactions do not proceed at a steady rate. They start off at a certain speed, then get slower and slower until they stop.

As the reaction progresses, the concentration of reactants decreases.

This reduces the frequency of collisions between particles and so the reaction slows down.



reactants
product

percentage completion of reaction



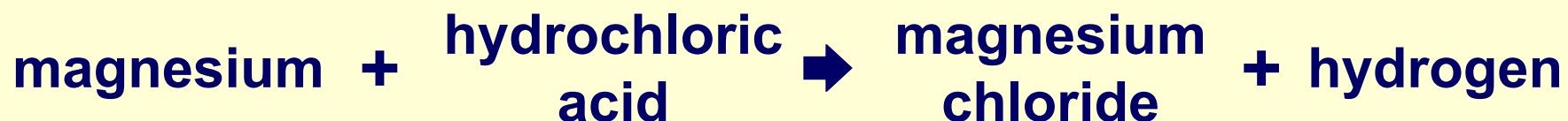


How can rate of reaction be measured?



Measuring the rate of a reaction means measuring the change in the amount of a reactant or the amount of a product.

What can be measured to calculate the rate of reaction between magnesium and hydrochloric acid?



- The amount of hydrochloric acid used up (mL/min).
- The amount of magnesium chloride produced (g/min).
- The amount of hydrogen product (mL/min).



Rates of Reaction

Contents

Particles and collisions

Temperature

Concentration

Surface area and catalysts

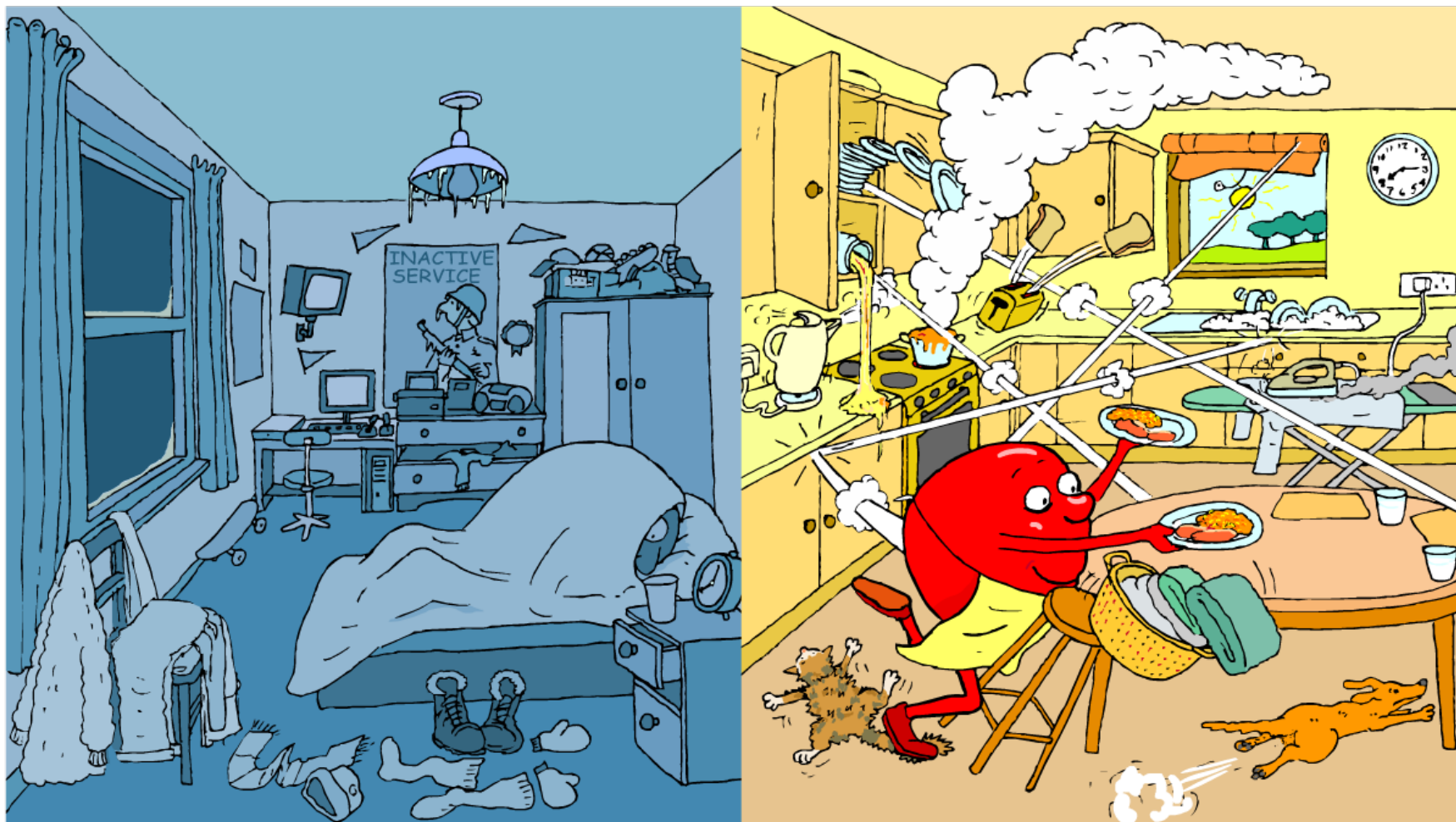
Summary activities





Temperature and collisions

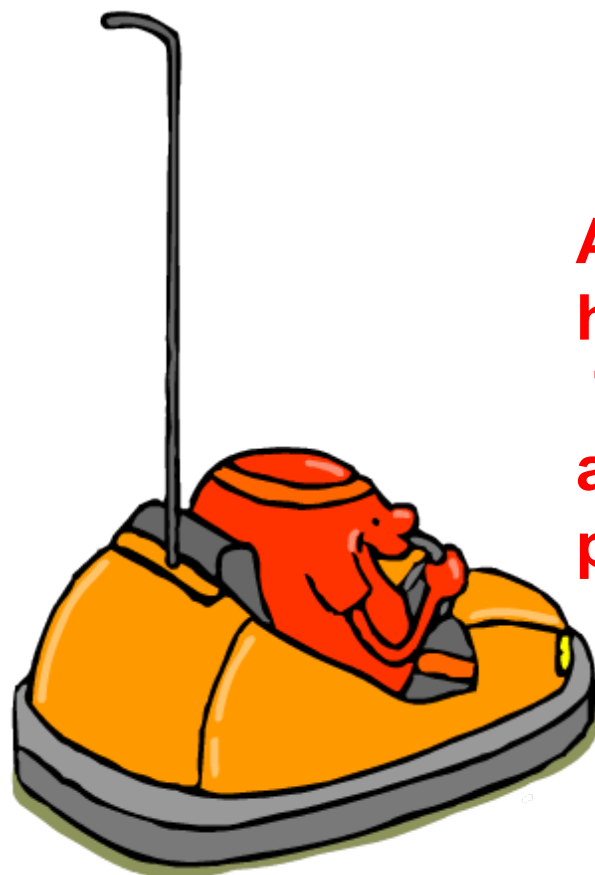
How does temperature affect the rate of particle collision?





Effect of temperature on rate

The higher the temperature, the faster the rate of a reaction. In many reactions, a rise in temperature of 10°C causes the rate of reaction to approximately double.



Why does increased temperature increase the rate of reaction?

At a higher temperature, particles have more energy.

This means they move faster and are more likely to collide with other particles.

When the particles collide, they do so with more energy, and so the number of successful collisions increases.





Temperature and batteries



Why are batteries more likely to rundown more quickly in cold weather?

At low temperatures the reaction that generates the electric current proceeds more slowly than at higher temperatures.

This means batteries are less likely to deliver enough current to meet demand.



Jupiterimages Corporation



Rates of Reaction

Contents

Particles and collisions

Temperature

Concentration

Surface area and catalysts

Summary activities





Effect of concentration on rate of reaction

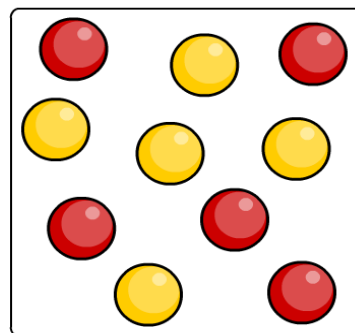
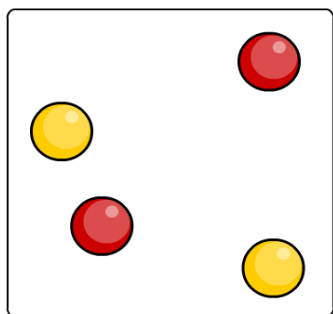


The higher the concentration of a dissolved reactant, the faster the rate of a reaction.

concentration – The number of molecules of a substance in a given volume.

Why does increased concentration increase the rate of reaction?

At a higher concentration, there are more particles in the same amount of space. This means that the particles are more likely to collide and therefore more likely to react.



lower concentration

higher concentration



Rates of Reaction

Contents

Particles and collisions

Temperature

Concentration

Surface area and catalysts

Summary activities



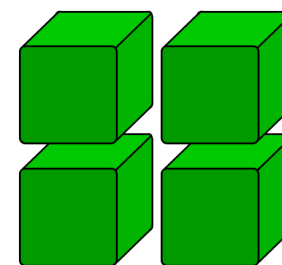
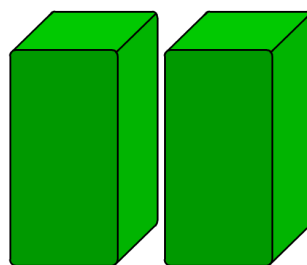
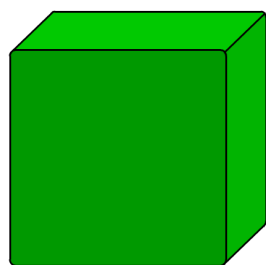


Effect of surface area on rate of reaction



Surface Area – the total area of an objects faces. Any reaction involving a solid can only take place at the surface of the solid.

If the solid is split into several pieces, the surface area increases. What effect will this have on rate of reaction?



low surface area

high surface area

This means that there is an increased area for the reactant particles to collide with.

The **smaller** the pieces, the **larger** the surface area. This means more collisions and a greater chance of reaction.

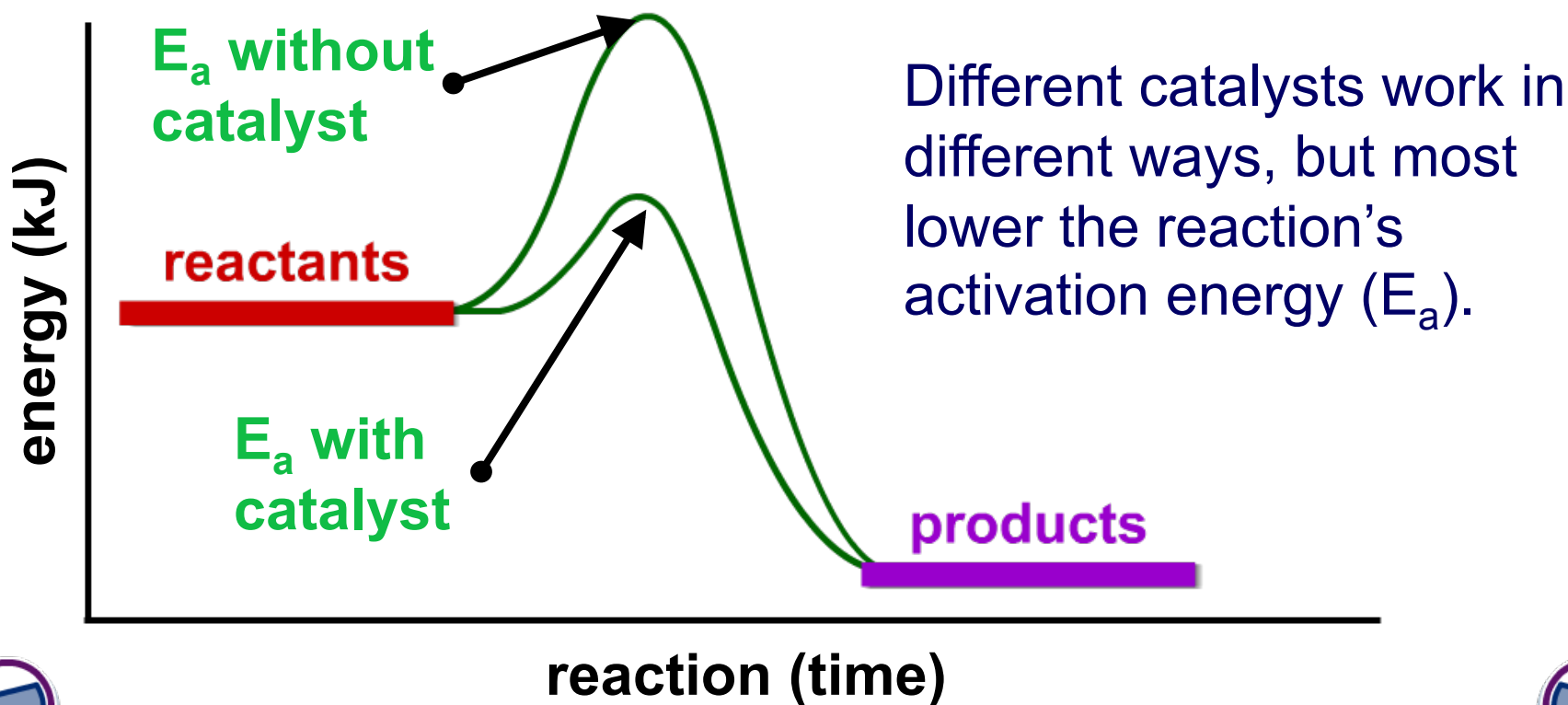




What are catalysts?

Catalysts are substances that change the rate of a reaction without being used up in the reaction.

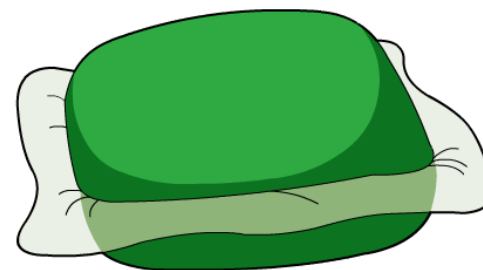
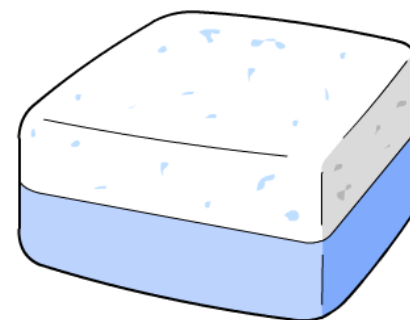
Catalysts never produce more product – they just produce the same amount more quickly.





Why are catalysts so important for industry?

- Products can be made more quickly, saving time and money.
- Catalysts reduce the need for high temperatures, saving fuel and reducing pollution.





Everyday catalysts



Many catalysts are transition metals or their compounds.
For example:

- **Nickel** is a catalyst in the production of margarine (hydrogenation of vegetable oils).
- **Iron** is a catalyst in the production of ammonia from nitrogen and hydrogen (the Haber process).
- **Platinum** is a catalyst in the catalytic converters of car exhausts. It catalyzes the conversion of carbon monoxide and nitrogen oxide into the less polluting carbon dioxide and nitrogen.

